Preliminary Evaluation of NMME Hindcast Results from FIM/iHYCOM Coupled Model

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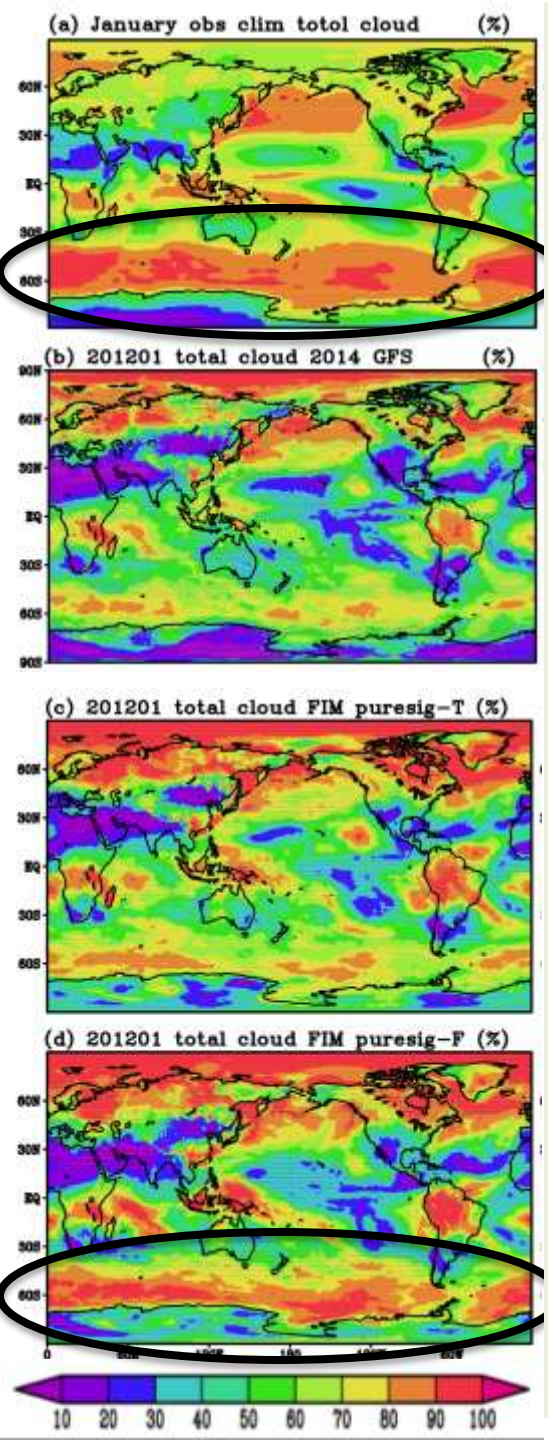
FIM numerical atmospheric model

- Horizontal grid
  - **Icosahedral,** Δx=240km/120km / 60km/30km/15km/10km
- Vertical grid
  - ptop = 0.5 hPa, θtop ~2200K
  - **Generalized vertical coordinate**
    - **Hybrid θ-σ** option (64L, 38L, 21L options currently)
    - **GFS-like σ-p option** (64 levels)

- Physics
  - GFS physics suites
    - May 2011 version, May 2013 McICA radiation),
    - 2015-GFS (incl. EDMF PBL),
    - WRF options esp. Grell-Freitas deep/shallow cumulus
- Coupled model extensions
  - Chem – WRF-chem/GOCART
  - Ocean – icosahedral HYCOM (no coupler),
    tri-polar HYCOM (with coupler)

	Atmospheric model	ocean model
CFSv2	GFS	MOM4
GFDL	AM2.1	MOM4
NCAR-CCSM4	CAM	POP
NASA-GEOSS	GEOS5	MOM4

- Many existing NMME models share similar atmospheric or ocean components, making the ensemble less desirable (over-confident?);
- The contribution from FIM/iHYCOM would add diversity in both atmospheric and ocean model.



1-month – Jan 2012

Obs clouds

GFS with 2014 physics – T574

FIM with GFS-like sigma vert coord

FIM with θ-σ vert coord

Much better clouds, critical for coupled application esp. in southern oceans.

2014-15 FIM/ESRL activities toward ESPC

- Continued development of FIM-HYCOM coupled atmos-ocean-chem model
  - Physics, dynamics, ocean
  - Seasonal and NWP evaluation

2015 – initial NMME hindcast tests

- Rerun blocking/stationary wave exps.
- Bleck et al. (2015-MWR, FIM article)

Atmos-only (AMIP) tests FIM/HYCOM coupled atmos/ocean model

- Horizontal grid
  - **Icosahedral,** Δx=30km
- Vertical grid
  - **Hybrid θ-σ** option (64L)
  - **GFS-like σ-p opt** (64L)
- Physics - 2014-GFS, Grell-Freitas scale-aware cumulus

Experiments – CMIP – FIM-HYCOM

- Horizontal resolution: 60km
- Vertical: Atmos: 64 layers
  - Ocean: 26 layers
  - Both using vertically adaptive grid
- Physics – atmos: GFS 2015 update physics
- Initial conditions: CFSR atmos & ocean
- Initial time: August 1st, 1982:2010
- Ensemble members 1 for each August 1st
- Forecast duration: 9 months

Observations & Verifications

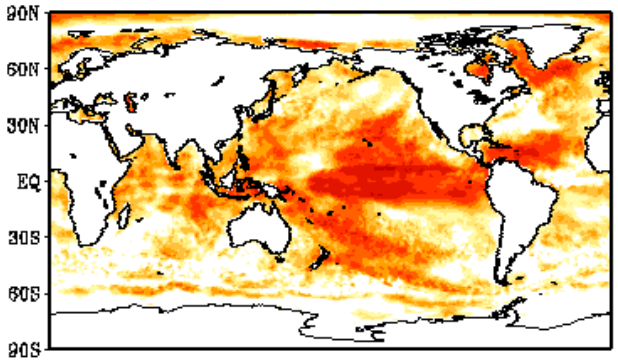
- SST: NOAA Optimum Interpolation (OISST, Reynolds et al. 2002)
- Precipitation: CMAP (Xie and Arkin 1997)
- T2m: GHCN_CAMS (Fan and van den Dool 2006)
- Verifications: follow Qin Zhang et al. 2011.

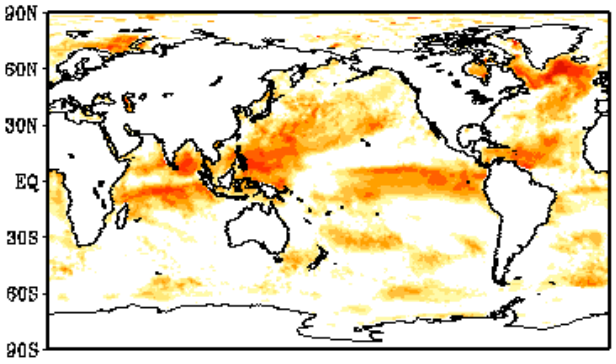
Anomaly Correlation of SST prediction with Aug ICs

SON (1 month lead)

DJF (4 month lead)

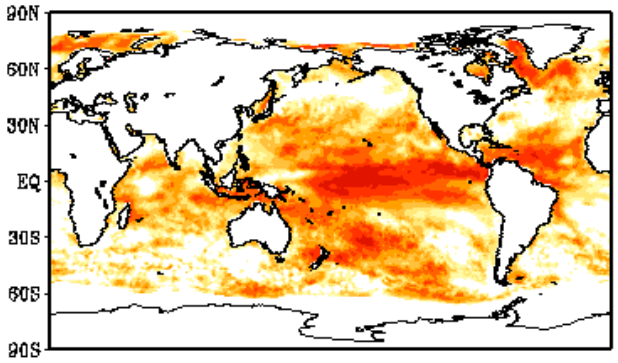
FIM
1 member



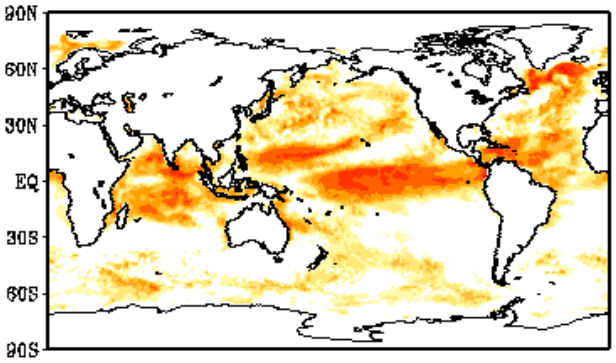


CFSv2
1 member

CFSv2 1 member (Aug IC for SON)

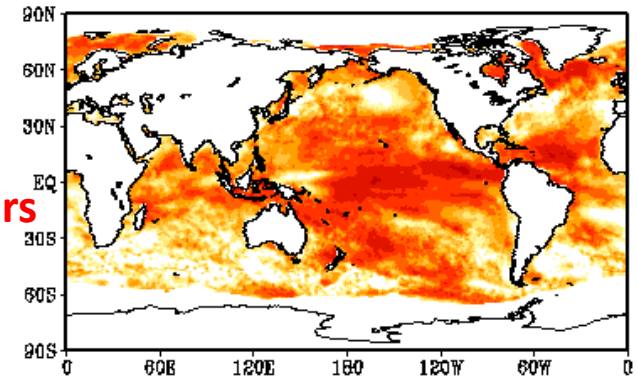


CFSv2 1 member (Aug IC for DJF)

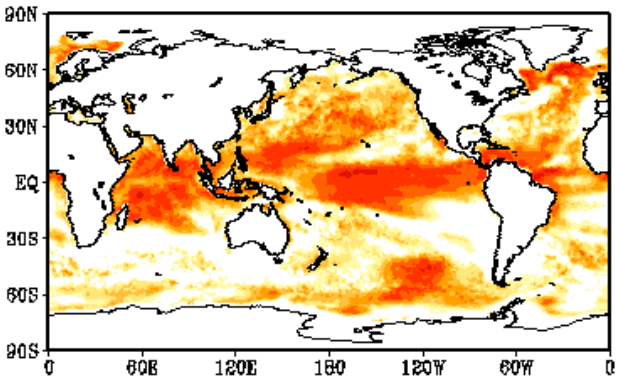


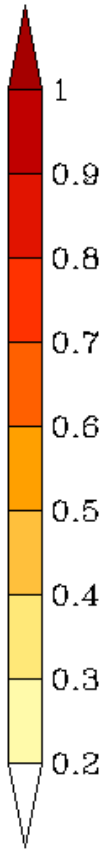
CFSv2
10 members

CFSv2 10 member (Aug IC for SON)



CFSv2 10 member (Aug IC for DJF)



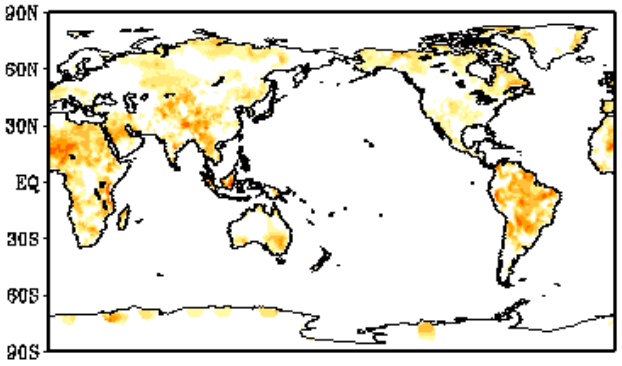


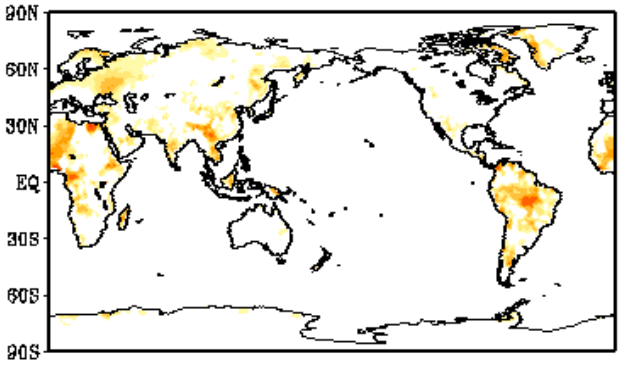
Anomaly Correlation of T2m prediction with Aug ICs

SON (1 month lead)

DJF (4 month lead)

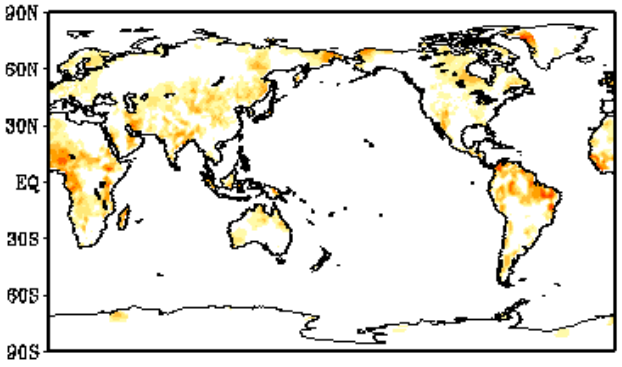
FIM
1 member



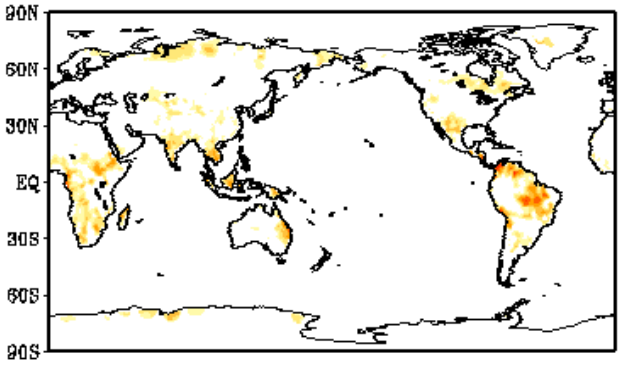


CFSv2
1 member

CFSv2 1 member (Aug IC for SON)

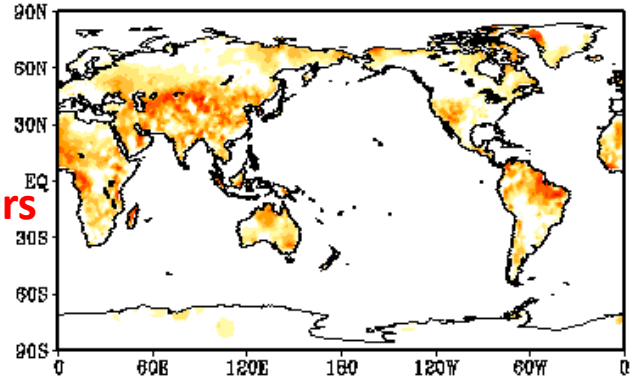


CFSv2 1 member (Aug IC for DJF)



CFSv2
10 members

CFSv2 10 member (Aug IC for SON)



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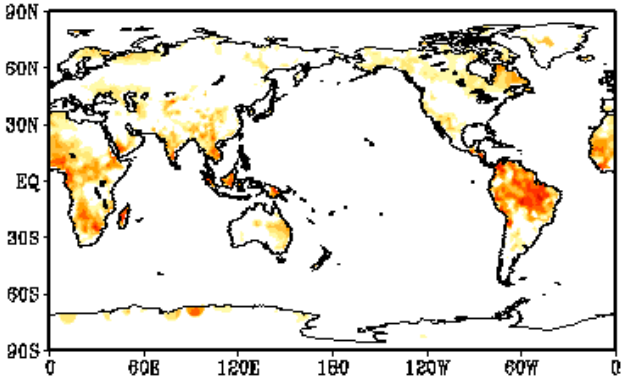
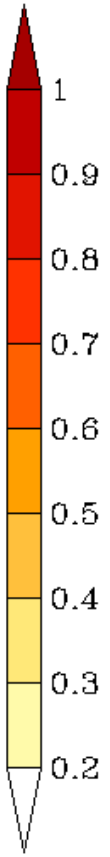


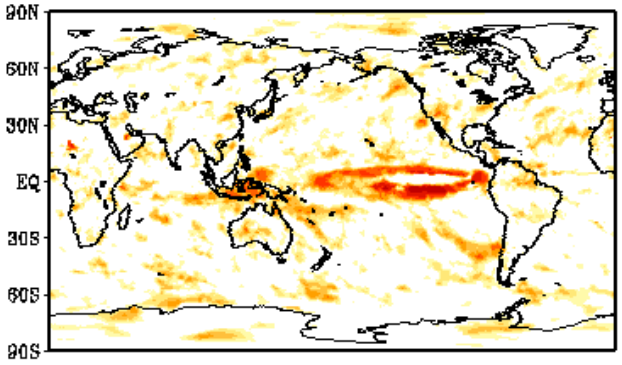


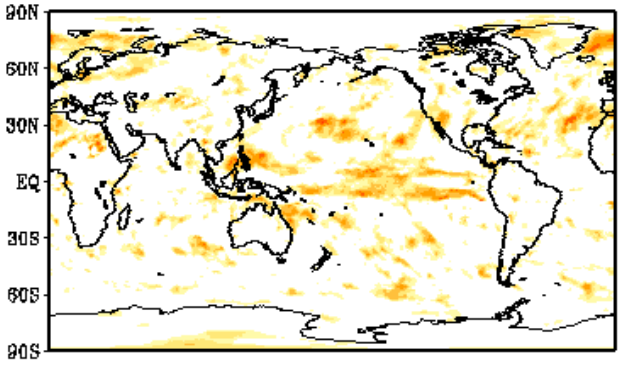
Anomaly Correlation of Precip prediction with Aug ICs

SON (1 month lead)

DJF (4 month lead)

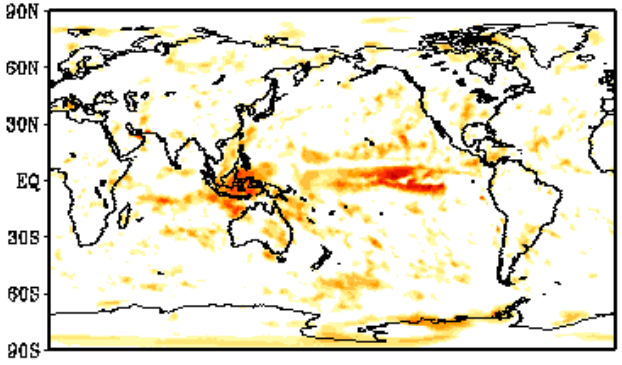
FIM
1 member



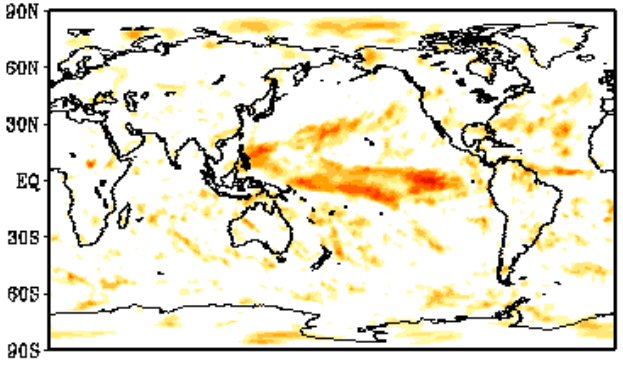


CFSv2
1 member

CFSv2 1 member (Aug IC for SON)

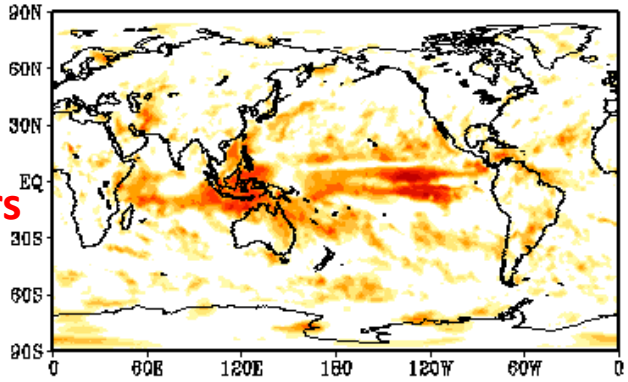


CFSv2 1 member (Aug IC for DJF)

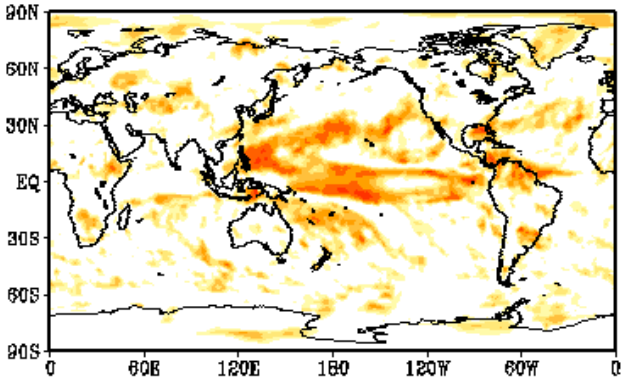


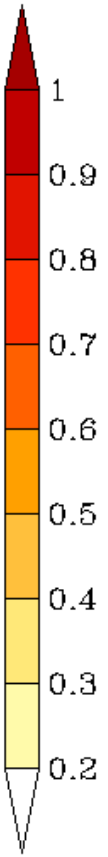
CFSv2
10 members

CFSv2 10 member (Aug IC for SON)



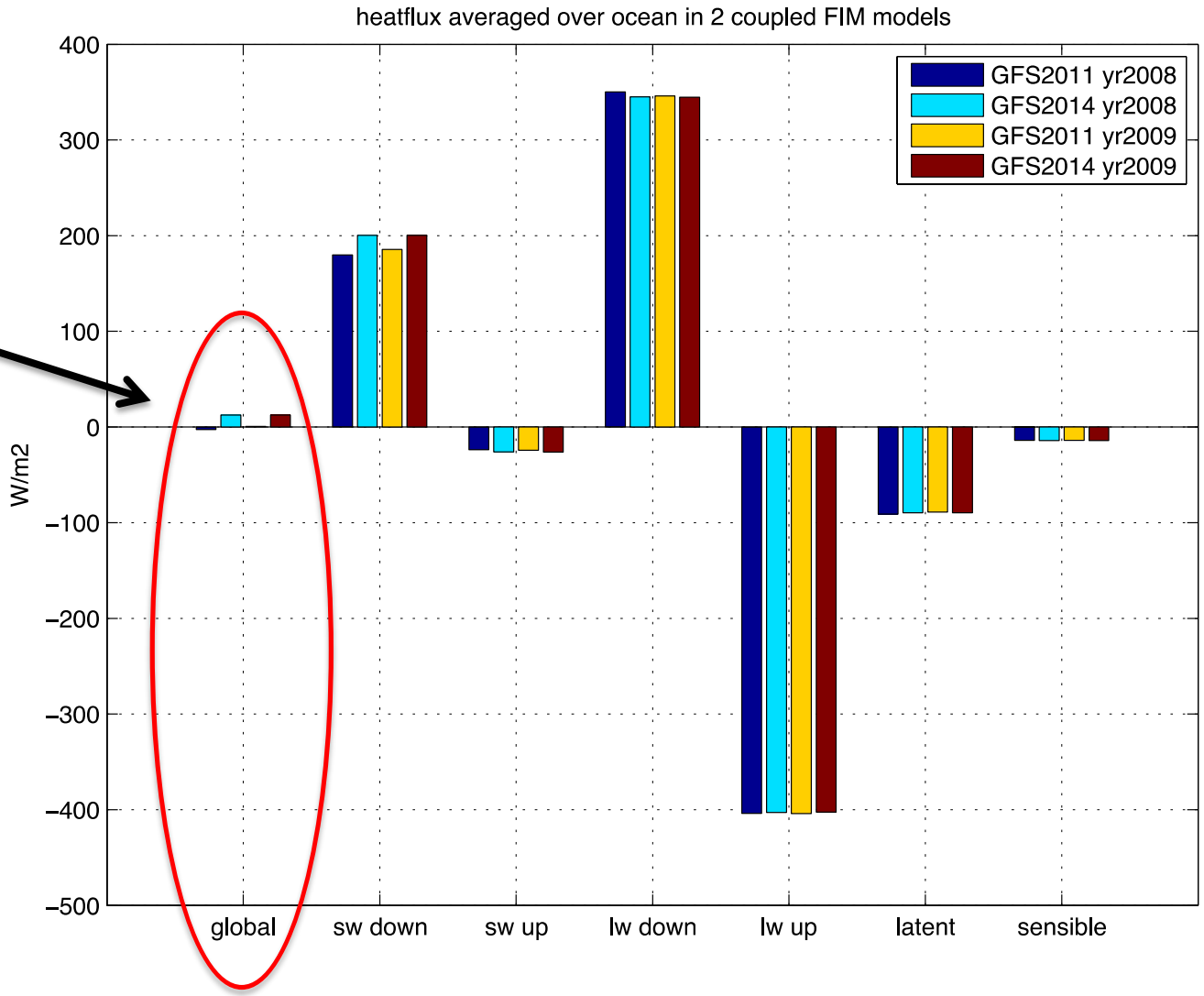
CFSv2 10 member (Aug IC for DJF)





Annual global surface heatflux budget (W/m^2) in 2 FIM (amip@g7)

GFS2011: 0.5 W/m^2
GFS2014: 12 W/m^2



	Time-range	Resol.	Ens. Size	Freq.	Hcsts	Hcst length	Hcst Freq	Hcst Size
ECMWF	D 0-32	T639/319L91	51	2/week	On the fly	Past 18y	2/weekly	11
UKMO	D 0-60	N96L85	4	daily	On the fly	1989-2003	4/month	3
NCEP	D 0-45	N126L64	4	4/daily	Fix	1999-2010	4/daily	1
EC	D 0-35	0.6x0.6L40	21	weekly	On the fly	Past 15y	weekly	4
CAWCR	D 0-60	T47L17	33	weekly	Fix	1981-2013	6/month	33
JMA	D 0-34	T159L60	50	weekly	Fix	1979-2009	3/month	5
KMA	D 0-60	N216L85	4	daily	On the fly	1996-2009	4/month	3
CMA	D 0-45	T106L40	4	daily	Fix	1992-now	daily	4
Met.Fr	D 0-60	T127L31	51	monthly	Fix	1981-2005	monthly	11
CNR	D 0-32	0.75x0.56 L54	40	weekly	Fix	1981-2010	6/month	1
HMCR	D 0-63	1.1x1.4 L28	20	weekly	Fix	1981-2010	weekly	10
FIM/HYC	D 0-60	30kmL64OL26	30	monthly	Fix	1999-2010	monthly	15

Added to Vitart and Robertson – S2S Prediction Project

Summary

- Preliminary evaluation of FIM/iHYCOM results suggests its monthly and seasonal prediction is credible;
- With one member starting at each August 1st from 1982 to 2010, FIM/iHYCOM shows comparable or better skill at 1 month lead in SON prediction than CFSv2, but is inferior at 4 month lead in DJF prediction. It is inferior to CFSv2 10-member ensemble. This is done without removal of systematic errors.
- More work is needed to achieve near zero heat flux at the surface, i.e., adding Grell-Freitas (2014) convection scheme in the atmosphere;
- More ensemble members and 30km horizontal resolution are in the plan for FIM/iHYCOM;
- Given that FIM and iHYCOM are very different from the current NMME models, they would add diversity to the NMME ensemble.